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M
WATERSHEDS
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SOME WATERSHED ASPECTS OF LOGGING ON NATIONAL FOREST LANDS IN REGION ONE

(WITH SPECIAL REFERENCE TO THE SPRUCE PROGRAM)

Examples of road building and logging activities in connection with the spruce beetle control and timber salvage program have been observed on most of the affected national forests of the region in an effort to evaluate the watershed problems involved. The field studies leading to this report were initiated primarily because of the "high ball" activity associated with the spruce logging program. The principles involved and the suggestions offered apply equally as well, however, to any logging activities on mountainous national forest lands of the region.

The fundamental responsibility of the Forest Service is the care and preservation of the many natural resources of the national forest lands. The many resources can be kept in a healthy, productive condition only by maintaining the land, the basic resource, in the best possible condition. As used here, the term "land" as "the basic resource" included the soil and soil forming materials and such features of the landscape as mountains, valleys, plains and stream courses.

Stream courses are Nature's drainage system and must be maintained in good condition in order that they may carry the runoff water in an orderly fashion, without undue flooding. (Fig. 1 and 2) Because the stream courses originating on the mountainous forest lands flow through the highly developed agricultural and industrial lowlands, and population centers, managers of these headwater areas have a tremendous responsibility to protect and care for the streams. Downstream channels can not operate effectively unless the headwater streams are in a stable, healthy condition.

The unit area of land drained by a given stream is a watershed. Management of that land primarily to perpetuate or improve its valuable characteristics is the fundamental objective of "watershed management." High quality water, in amounts determined largely by nature, is a natural product of good watershed management and in much of Region One is the most important and valuable product or usable resource of the national forest lands.

Fig. 1. This reach of White Sand Creek with its clear channel and stable banks carries tremendous amounts of runoff from high west slopes of the Bitterroot Mountains each spring without damage. Though probably ideal in this situation, this is not necessarily the type of channel that would be most desirable for all of our mountain streams.

Fig. 2. Channels cluttered with debris or conjested by log jams become unstable, cutting into their banks and plugging the channels with sediment bars. The example shown here is a natural situation on papoose creek, Powell District, Lolo National Forest. Such conditions are very undesirable whether natural or man-caused.

Most of the national forest lands of the region, if properly managed, are capable of sustained production of one or more valuable products in addition to water, such as timber, forage for domestic stock and wildlife, recreation, etc. Some lands are also susceptible to management to influence the timing, quality and quantity of water produced. This is essentially the land use phase of "water management." All these products, including water, must be harvested only to the extent and in a manner fully compatible with the objective of maintaining the land itself in good condition. This has always been the basic philosophy of the Forest Service.

Sometimes actual practices have strayed somewhat from this philosophy. By reading the evidence on the ground it appears that in some aspects straying has been a rather common practice. "Emergency programs," "war effort," and various other more or less critical situations have served in various degrees to swerve actual practices from the basic Forest Service objective. Since "normal times" are actually only a figment of the imagination, and emergencies and crises of various sorts are the order of the day, it behooves us to keep our objective in mind at all times and to swerve from it less readily. There will never be a time when it will be easy to do the job that we must do.

In some respects the logging program is straying from our objective of caring for the basic resource. Some of the practices being used in combating the spruce beetles, such as clear-cutting and logging of infested and other trees along streams, pose a serious threat to stability of important stream channels. It is entirely possible that in the not too distant future this Region may be asking the Treasury for large sums of money for emergency repair of flood damages to stream channels and cultural improvements. To varying degrees, the damages may be a direct result of the spruce logging program unless certain practices are changed promptly and effectively. Equally dangerous practices were observed on some north Idaho forests on other than spruce sales.

As an example of what could happen almost anywhere, consider the fact that on the Lewis and Clark National Forest an estimated $33,000 was spent in November and December 1953 to clear debris from about 55 miles of the most seriously flood-damaged stream channels in the Little Belt and Highwood Mountain areas. This work is being done in an effort to give a reasonable degree of protection to a similar type of channel repair costing an estimated $300,000 that is being done downstream by the Soil Conservation Service and Corps of Engineers. The degree of repair is tuned to estimated "normal" runoff conditions. Engineers readily admit that much of the effort may be lost if unusually high runoff strikes these streams before the channels can be stabilized further. Most of the damage to stream channels and much of the five million dollar damage to homes, farms, industries, and transportation systems which occurred in the Great Falls vicinity in June of 1953 is directly traceable to the deteriorated condition of the stream channels. Channels had become so choked with debris and sediment resulting from mining, logging, road building, grazing and farming, and by natural causes such as beaver

dams, windfall, etc., that when unusually heavy runoff occurred as a result of abnormally high preciptation the channels not only were unable to contain the flow but they were very seriously damaged and their capacities further restricted. (Figs. 3 and 4.)

Land Erosion

In general, the spruce areas are probably somewhat less subject to erosion than much of the pine and fir land that has been logged in recent years. The necessity for clear-cutting and controlled broadcast or dozer piling and burning in some situations increases the erosion hazard on these areas. (Fig. 5) However, if full use is made of currently approved practices for controlling erosion on skid trails, landings, roads and burns, soil erosion from the land surface can probably be kept within reasonable limits. In some areas full use has not been made of known erosion control practices and accelerated erosion is already started. (Fig. 6)

Effect on Streamflow

Regardless of whether the bug-killed spruce is logged or left to rot in the forest, we must expect a significant increase in runoff from bug-killed areas. This increase will be even greater when the spruce is logged than when not logged, and any other species logged along with the spruce will increase the flows still more. Just how great these increases will be will depend on a variety of complicated conditions. We all know, however, that spruce grows on moist sites because it requires a lot of water for good growth. Therefore, when the spruce is all killed and removed, and until other vegetation takes over the site, much more water will be available for runoff. It has been estimated that this could easily amount to as much as 15 to 20 inches per year of additional runoff from the net clear-cut areas. What this would amount to in terms of streamflow for a given watershed would depend, of course, upon the proportion of the area killed or logged.

The increased runoff, provided the operation does not induce a significant amount of surface runoff, may be expected to increase streamflow during both low and high flow seasons, but the relative seasonal increases will depend largely upon the nature of the spring snow melt season. There is absolutely no assurance that in some years the great bulk of the increase will not come during the spring high water period and contribute to severe flooding; in fact, the greatest increase may generally be expected during this period. Depending upon the weather, topography, aspect, soil depth, geology and other factors in a complicated interrelationship, the effect of clear-cutting portions of a watershed will vary from year to year and from area to area. (Fig. 7) In some situations it may tend to reduce the actual peak flows by encouraging earlier or later melt on the clearcut areas. Sometimes

Fig. 3. When unusually high flood flows hit streams whose channels were already partially plugged with debris and sediment the channels and adjacent cultural improvements are seriously damaged. This condition on Hoover Creek is typical of many miles of stream channel in the Little Belt and Highwood Mountains which were damaged by debris-laden waters of June 1953. Lewis and Clark National Forest.

Fig. 4. This pile of debris gathered together in Belt Creek by the June 1953 flood is mute evidence that the channel was cluttered with debris before the flood. Lewis and Clark National Forest.

Fig. 5. An example of a bug infested spruce area which had to be clear-cut and burned. Some of this was dozer piled before burning. In some situations such treatment may pose serious watershed problems. Lost Park Creek, Lolo National Forest.

Fig. 6. The young gullies in both of these skid trails on a spruce logging job on a western Montana national forest suggest that the "emergency" nature of the program has encouraged neglect of long established erosion control practices.

it may cause bunching up of high flows from small tributaries with resulting increases in peak flows. Until we know considerably more about these complicated relationships it seems wise to keep drastic changes in cover, such as clear cutting, to the absolute minimum. Therefore, especially in areas where clear cutting is considered essential to success of the control program, we must keep in mind the fact that our stream channels will have to carry more than normal run-off and possibly higher than usual peak flows.

Care of Stream Channels

The greatest watershed threat of the spruce program is to the stability of the stream channels. This threat is twofold. First is the fact that the streams must carry more water than they would normally have to carry. Second is the fact that nearly every impact that the road building and logging program has upon stream channels is more likely to be detrimental than beneficial to them. (Fig. 8) Thus, if extreme care is not taken, streams with less than natural capacity will have to carry greater than normal flows and the results are likely to be disastrous, costly and long lasting. Some of the common hazards are logging debris, disturbed stream banks, sediment from eroding skid trails and roads, road fills which restrict channels, bridges and culverts which collect debris, and straightened channels with increased gradients. (Figs. 9 and 10) Even in the best planned and executed program each of these hazards is bound to exist to some degree. Every effort must be made, therefore, to keep these damages to a minimum because anything that seriously disturbs a stream channel and causes stream bank erosion in the headwaters may well start a chain reaction that will work its way down stream at least to the first large lake or reservoir. The chain reaction may move rapidly or very slowly, but once started, it continues indefinitely and is very difficult or impossible to stop. A stream channel, once seriously damaged, is extremely difficult or impossible to repair satisfactorily.

Logging debris and road fills are a special threat to any stream able, during the peak runoff, to float logging debris and sediment and thus to build debris dams and sediment bars. Debris dams in our swift flowing mountain streams are clearly detrimental at high water stages. Any beneficial effect that debris dams may have in retarding flows and trapping sediment is far overbalanced in most cases by the damage they do. Debris dams induce bank cutting and divert flows into new channels where more debris and sediment are picked up. They sometimes build up heads of water and then break loose to release a surge of water, debris and sediment capable of sweeping away bridges or washing out road grades that could easily withstand ordinary peak flows of debris-free water.

Fig. 7. Snow remained longer on these clear-cut areas than in the adjacent timber in 1953, due either to more snow or slower melting in the open. Clear-cut areas have generally melted first at Priest River Experimental Forest in north Idaho. Clear-cutting half of an area receiving up to 12 feet of snow may be pressing our luck a bit far. Sisters Basin area, St. Joe National Forest.

Fig. 8. To provide get-away for a small culvert on a spruce program road on a north Idaho national forest, an estimated 100 cubic yards of earth were pushed into this stream channel. This example is unusual but demonstrates a general lack of appreciation of the importance of maintaining channel stability. These 100 cubic yards may well cause bank cutting that could release many more hundreds of cubic yards between here and the mouth of the stream.

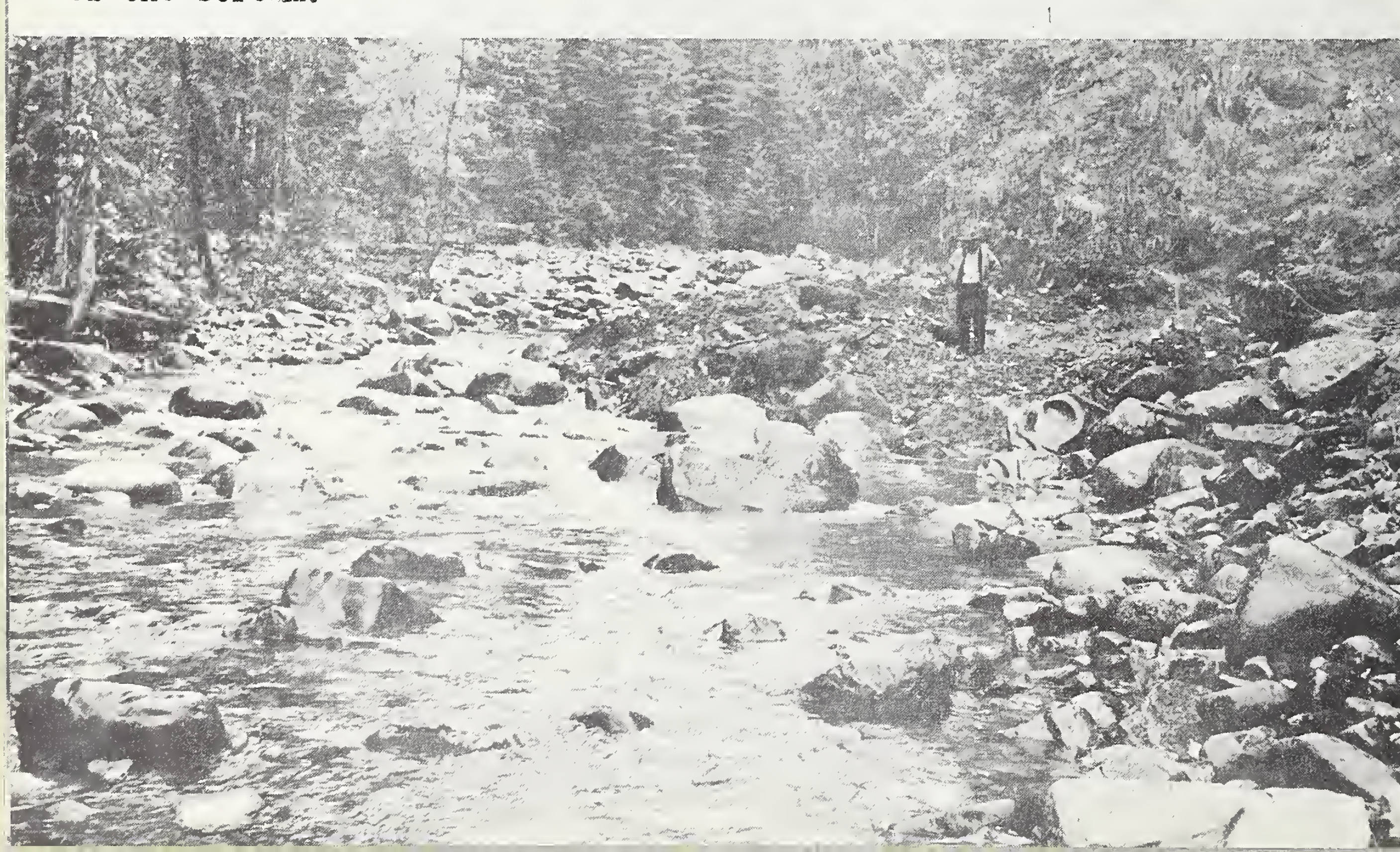

Fig. 9. The road above this bridge is being extended into a spruce area which is to be clear-cut. Within 100 yards above this partly plugged bridge there are several debris dams from 3 to 8 feet high as a result of past logging or cedar cutting. Given increased flows and additional debris, this is a dangerous situation. It is not unique to the one Idaho forest on which this picture was taken.

Fig. 10. This picture demonstrates clearly how material picked up by cutting into the highway embankment was deposited in the middle of the stream, causing the water to cut far into the meadow on the right, and though not clear in the picture, into the road grade on the left. The Belt Creek channel had been rerouted to fit desired alignment of the highway. Damage was caused by the June 1953 flood.

Heavy sediment picked up as a stream cuts into a natural stream bank or a road grade to go around a log jam is deposited in the bottom of the channel somewhere downstream - some in open reaches, some under bridges and in culverts. This sediment in the bottom decreases the capacity of the channel to carry water. Thus, when high water occurs, the stream overflows its banks that much sooner and bridges, partly plugged with gravel, are no longer able to carry the flow. Bank cutting induced by debris dams undermines trees and shrubs which topple into the water, thus adding to the load of debris and sediment. The fine sediment is carried farther downstream where it is deposited in a reach of slow-moving water as in the Kootenai below Bonners Ferry, in a lake or reservoir or on a flood plain where the stream overflows. Sediment in water increases the specific gravity of the fluid, thus increasing its ability to carry coarser sediment and heavier debris. Coarse sediment and debris greatly increase the mechanical scouring action of flood flows. Thus both land and bank erosion, by adding sediment, increase the destructive power of running water.

The lower reaches of many of our streams are already in bad condition, having been choked with debris dams, gravel bars, road fills and inadequate bridges and culverts as a result of logging, fire, mining, etc., of the past. (Figs. 11 and 12) In view of this situation it is extremely urgent that in our current and future logging programs we must make every effort to keep logging debris, even concentrations of small branches, etc., out of channels. This material lodged against established debris dams will make them less porous and thus increase their potential for causing damage. (Fig. 13)

In recognition of the established fact that streamflow will be increased by the spruce program, especially from clearcut areas, there is much to justify the judicious removal of existing log jams which are likely to plug with fine debris and obviously will interfere with the ability of the streams to carry above-normal flows in an orderly manner. This is not meant to suggest removal of logs that have become a natural part of a relatively stable channel. Where logs are firmly imbedded with sediment filled in above them it is probable that their removal might cause more disturbance than leaving them in place, provided they do not form a bottleneck which is likely to collect floating debris. These logs will eventually rot away and the sediment stored behind them will then be released but there is no point in causing this disturbance at the same time as the logging operation. Criteria for determining which logs and debris should be removed and which left have not been developed very far, but experience with the more obvious cases should help to establish some of the necessary guides. (Fig. 14)

Fig. 11. This abandoned bridge across a stream on a western Montana forest is a serious bottleneck which should have been removed long ago. There are many such, not only on the national forests but elsewhere as well, throughout the Region. This condition is a result of early logging but must be reckoned with now that several spruce areas are being clear-cut in the headwaters of this stream.

Fig. 12. This view shows how the bottleneck seen in Figure 11 has caused many cubic yards of earth to be taken from the bank below the bridge. Most of this material is now in the bottom of the channel some place down stream. This is an obvious example of the milder type of stream channel disturbance typically caused by degris jams in swift flowing mountain streams.

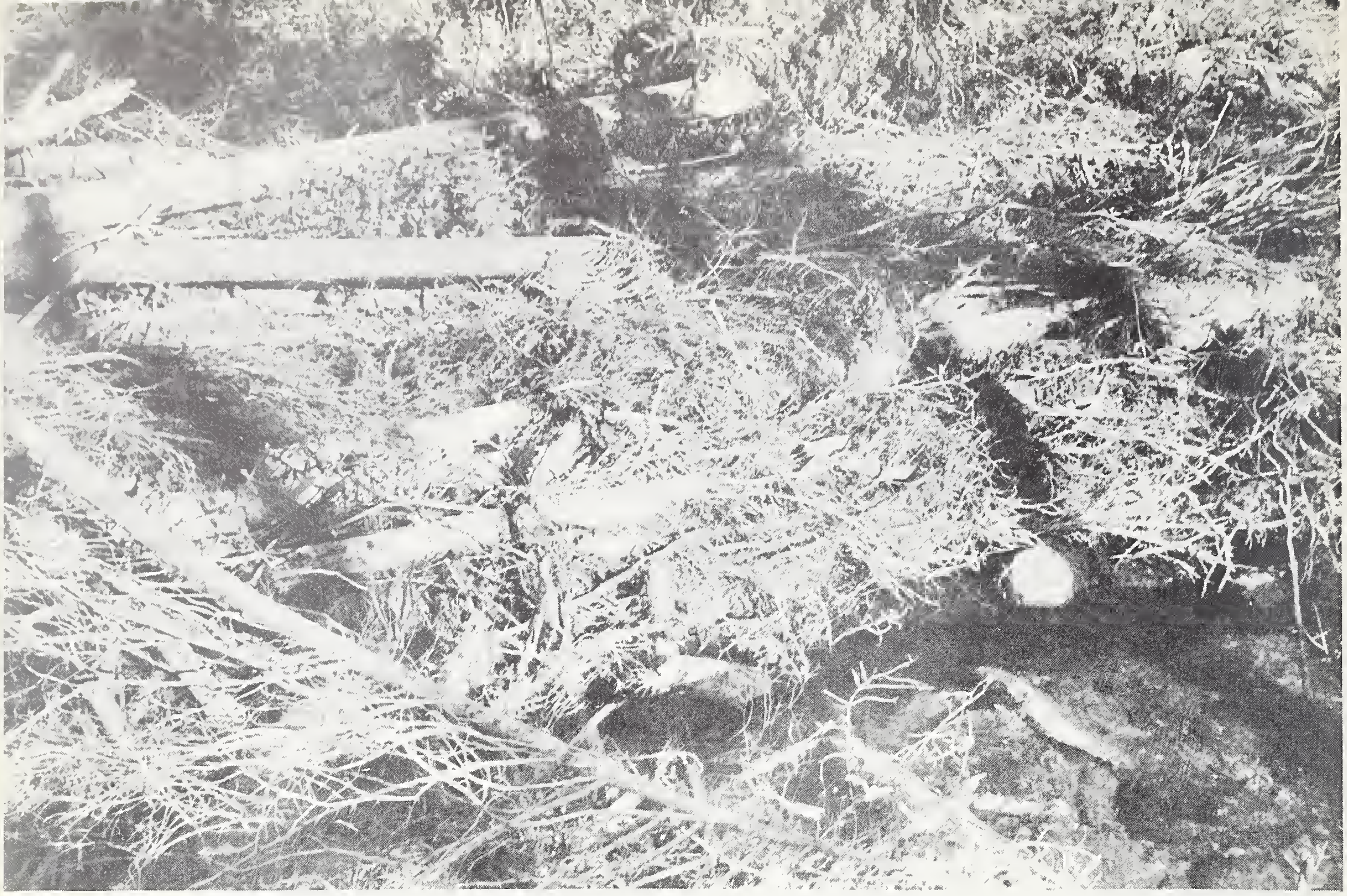

Fig. 13. The framework of this jam on a western Montana national forest is of natural origin and was in place before the 1952 clear-cut spruce logging occurred. The 1953 spring runoff packed fine logging slash against the upstream face thus making the dam less porous and more dangerous. Obviously this jam should be removed.

Fig. 14. This log jam which is one of several within one-half mile above the bridge seen in Figures 11 and 12 is another example of the type of jam which obviously should be removed.

SUMMARY AND RECOMMENDATIONS

A discussion such as this would be of limited value unless it culminated in rather specific suggestions for improvement.

Some suggestions follow, not necessarily in any logical order of importance because this will vary from one situation to another:

1. Fall streamside trees, which must be cut, away from the stream even though this may require special measures.

2. Keep tractors and other equipment out of channels and away from the banks except for the minimum number of necessary crossings which should be carefully selected and protected as needed to assure that they do not become sore spots in the channel.

3. Keep logging and road building debris out of streams and out of reach of high water. This is far preferable to letting the debris get in and then trying to remove it afterwards. (Fig. 15)

4. Remove such debris as does get into the streams, using every care to keep from tearing up the banks in the process. A "cat" with a boom would seem ideal for this job when the debris is too heavy to be handled by hand. In some situations it can be done with a jammer. When channel clearing, do not allow tractors or other equipment in the channel except when absolutely necessary as to remove sediment or to open up a crossing. (Fig. 16)

5. Consider carefully the desirability of removing existing jams and obstructions where it appears that these may be a threat to channel stability under the new conditions, keeping in mind that even fine trash from a disturbed area can plug existing porous log jams and cause trouble. Do not interpret this suggestion as a mandate to clear all natural logs and debris indiscriminately from stream channels or to take other measures that will tend to turn them into mill races. In clearing log jams do not disturb logs which are imbedded in the stream bed or bank. More detailed suggestions for stream channel protection will be issued as rapidly as they are developed.

6. Consider the effect of logging not only to the reach of stream in the immediate vicinity of the logging but also for a considerable distance downstream. There may be log jams or other bottlenecks down there that will cause trouble under the new conditions of runoff.

7. On current sale areas where streams are already badly cluttered with new or old debris, consider the advisability of using a portion of available erosion money, if necessary, for channel cleanup and protection even though this may mean allowing some additional erosion back on the land.

Fig. 15. The logging debris in this channel on a western Montana national forest is to be removed by the operator. This will be very difficult to do without causing additional damage to the channel. It would be far better if such debris was never allowed to get into the stream.

Fig. 16. About one-half mile above the view in Figure 15 a "TD-24" bogged down near the stream. Before the forester in charge became aware of the situation the operator had "cleared" some 200-300 feet of channel. Imagine how much of this loose earth and trash could be moved by a 3-4 foot head of water next spring. Dozers must be kept out of small stream channels!

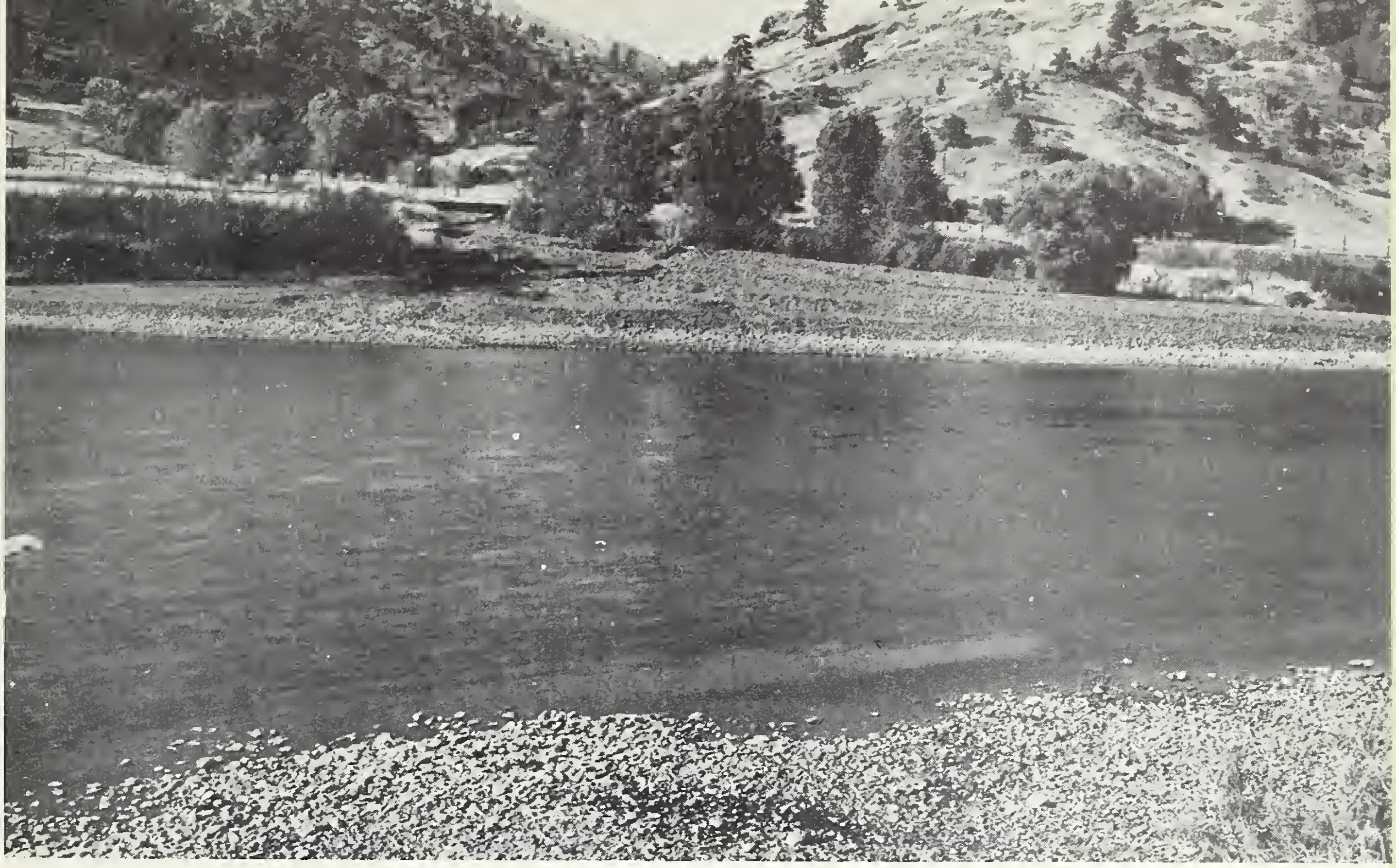

Fig. 17. The relationship between conditions on small tributary streams and major rivers is strikingly demonstrated by the many thousands of cubic yards of gravel which Andy Creek dumped into the Missouri River during the June 1953 flood. Sediment-laden waters from overgrazed range land did this even without the aid of logging debris.

Fig. 18. Much of the material in this log jam which caused $3,000 damage to the Van Buren Street Bridge across the Clark Fork River at Missoula doubtless originated as logging debris in tributary streams. This is another clear example of the direct relation between land use practices in the headwaters and welfare of downstream areas.

8. In future sales, provision should be made for sufficient funds to do both the erosion prevention on the sale area and such stream cleanup and protection as may be necessary to assure channel stability and minimize the danger of damaging floods.

9. Logging for control of the spruce beetle sometimes requires cutting of infested trees right down to the stream edge. Wherever feasible, enough thrifty, windfirm trees of other species should be left along the streams to give maximum protection to the banks. Protect streamside brush and grass from fire and mechanical injury. This will help to preserve the fish habitat as well as stability of the channels.

10. When building roads in and below logging areas be sure that bridges and culverts are large enough to carry unusually high flows and so constructed as to minimize the probability of plugging with debris.

11. Road grades should not restrict channels or put loose material into situations where it is likely to be carried away by running water. The damage to the stream is likely to be even greater than to the road.

12. Accepted measures for preventing erosion on roads, skid trails, landings and burns should be faithfully used.

13. Remember that what happens to the stream channels and land conditions in headwater areas is reflected in stream behavior downstream where flood waters must pass through valuable agricultural and heavily populated flood plain areas. Therefore, our responsibility to maintain stable conditions along our forest streams is far-reaching. (Figs. 17 and 18)